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**Forbes**

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(54) **RAILROAD GONDOLA CAR STRUCTURE**

(75) Inventor: **James W. Forbes**, Campbellville, CA (US)

(73) Assignee: **National Steel Car Limited**, Hamilton, ON (CA)

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***B61D 17/00*** (2006.01)
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***B61F 1/12*** (2006.01)

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CPC .. ***B61D 17/08*** (2013.01); ***B61F 1/12*** (2013.01)

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USPC ........... 104/406.1, 406.2, 396, 404, 411, 413, 104/416, 417, 418, 419
See application file for complete search history.

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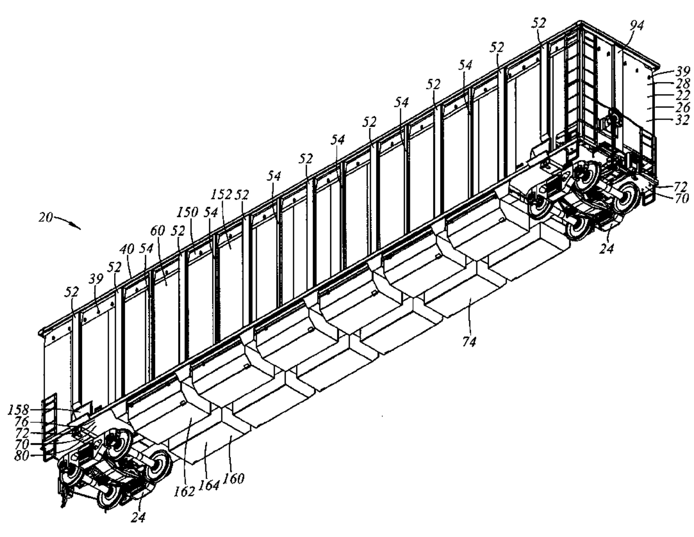
*Primary Examiner* — Jason C Smith
(74) *Attorney, Agent, or Firm* — Hahn Loeser & Parks LLP

(57) **ABSTRACT**

A gondola car has a body for lading carried on an underframe. The underframe includes a center sill and cross-bearers. The car has deep side beams having top chords, side sills, and side sheets. The lower portion of the car includes tubs that seat between the cross-bearers. The car may have an internal volume of more than 8000 cu. ft. The car may have rotary dump claw sockets. The car has opposed internal and external stiffeners aligned at the longitudinal stations of the cross-bearers. The internal stiffeners may be triangular cantilevers extending upwardly inside the side sheets. The side sheet lies intermediate the stiffeners and their flanges. The top chords may be wider in cross-section than the side sills. The side sills may define torque tubes that co-operate with the sidewall stiffeners and the top chords to resist lateral deflection. The car may include a false deck, or dog-house at one end to accommodate the brake reservoir and brake valve, such that the car is longitudinally asymmetric.

**15 Claims, 11 Drawing Sheets**



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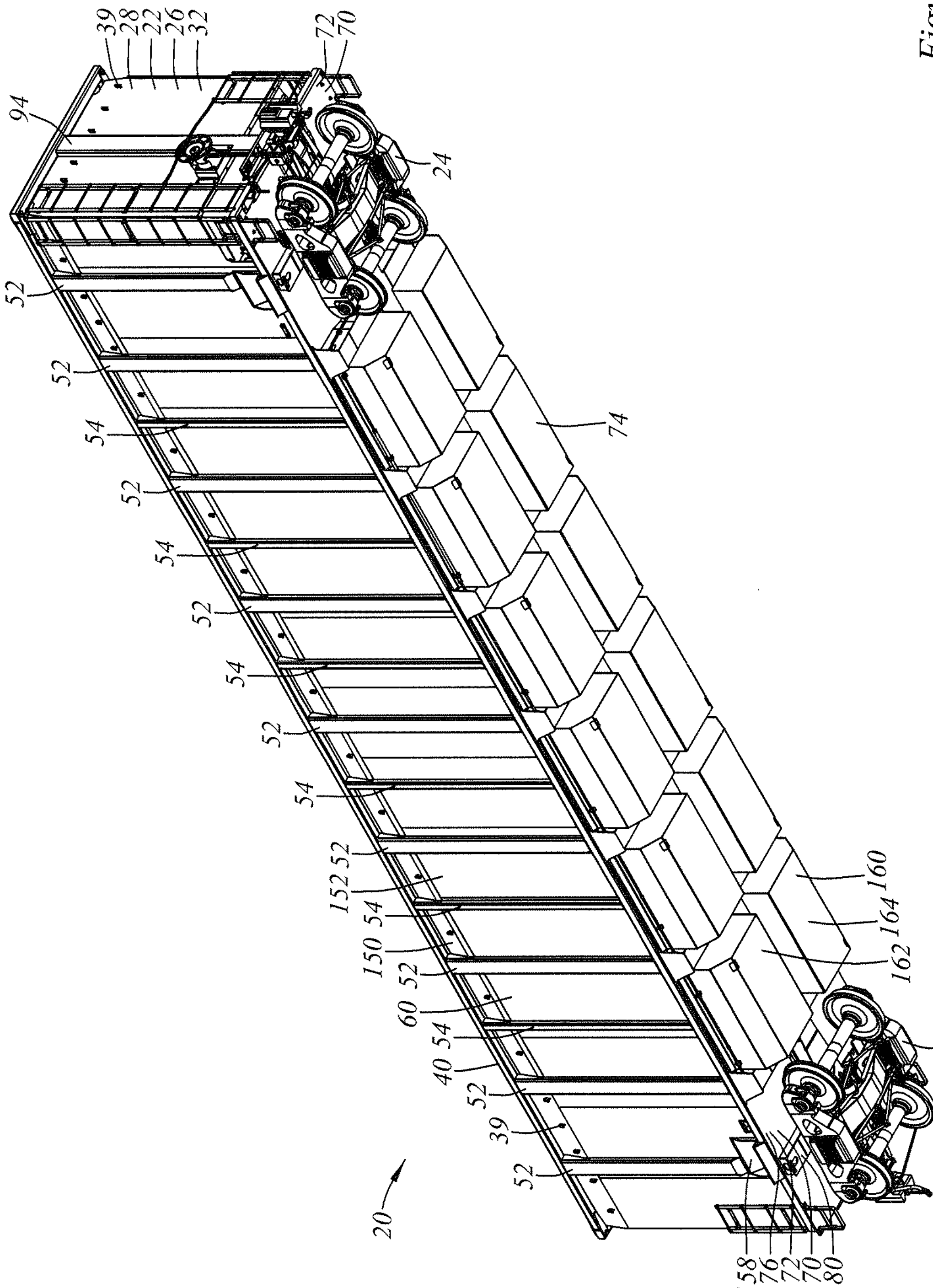
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Figure 1a

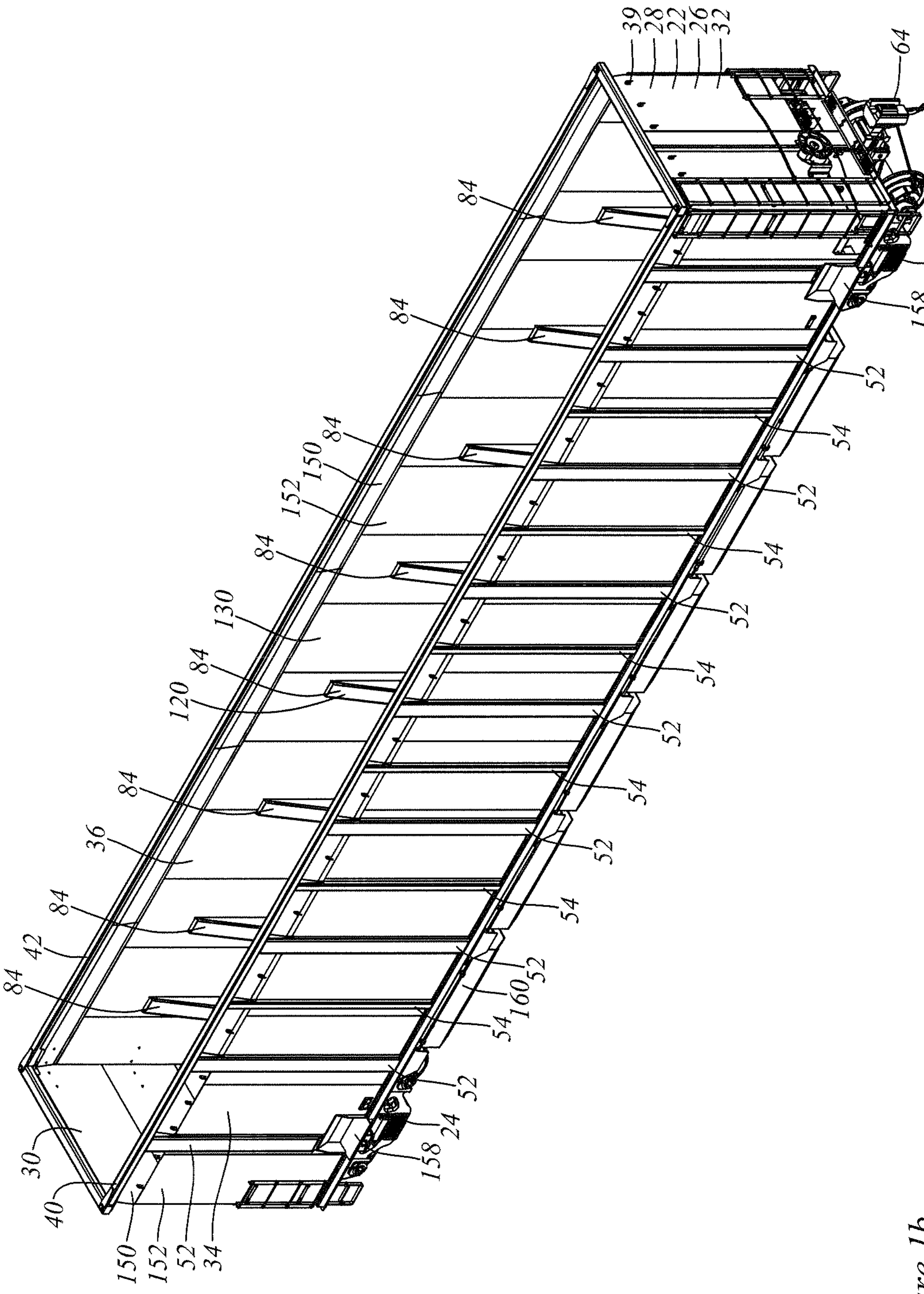


Figure 1b

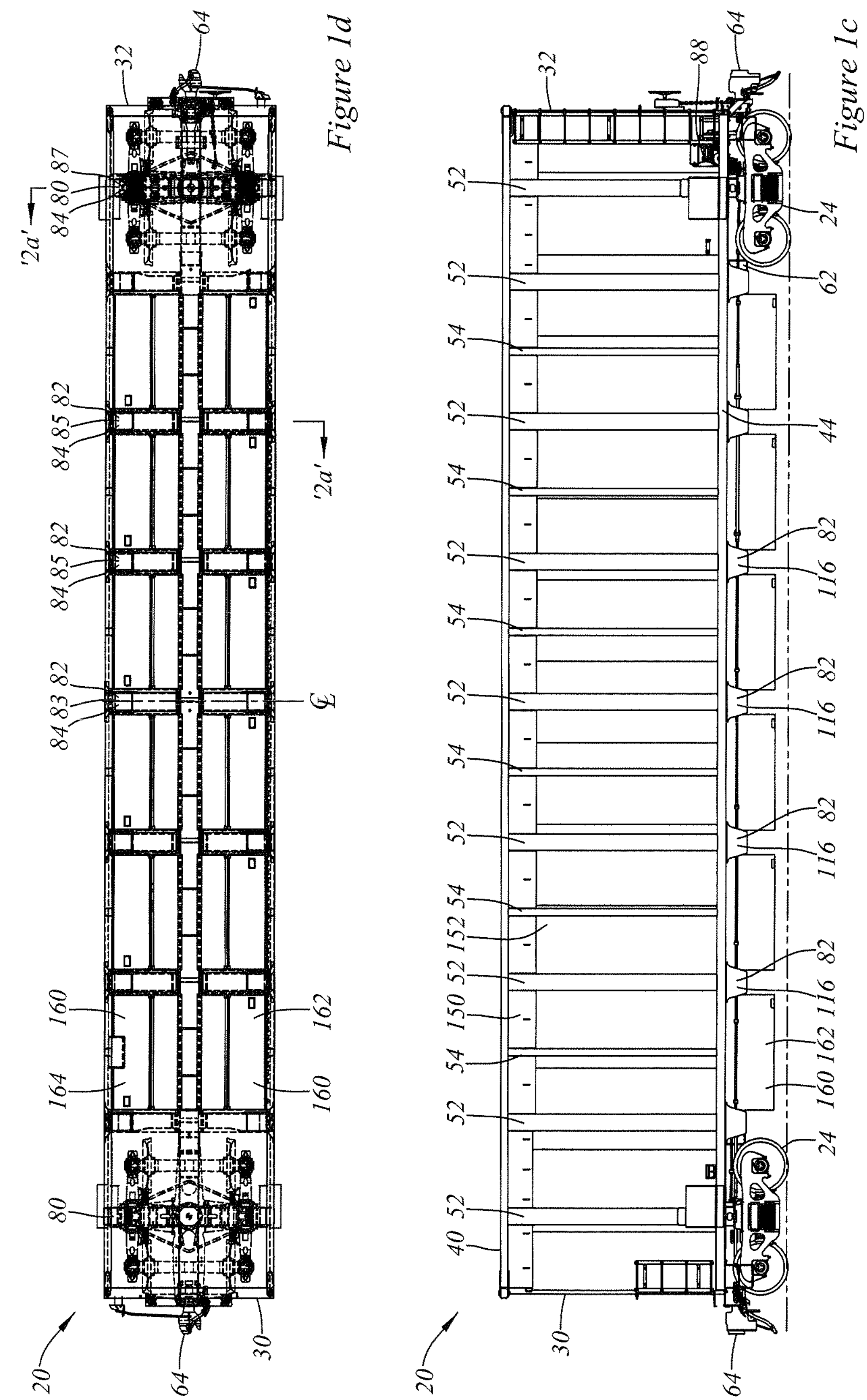

Figure 1d

Figure 1c

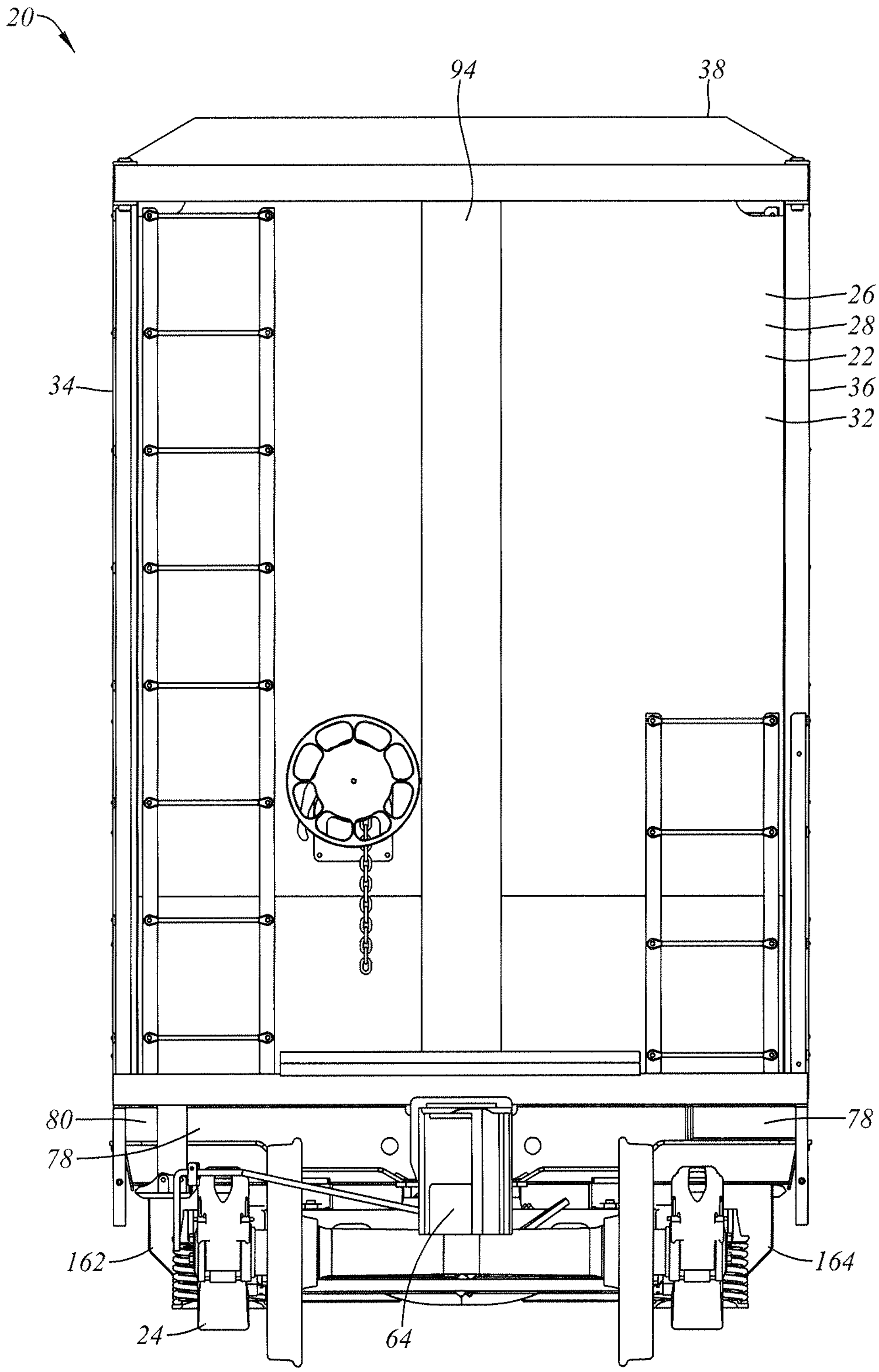


Figure 1e

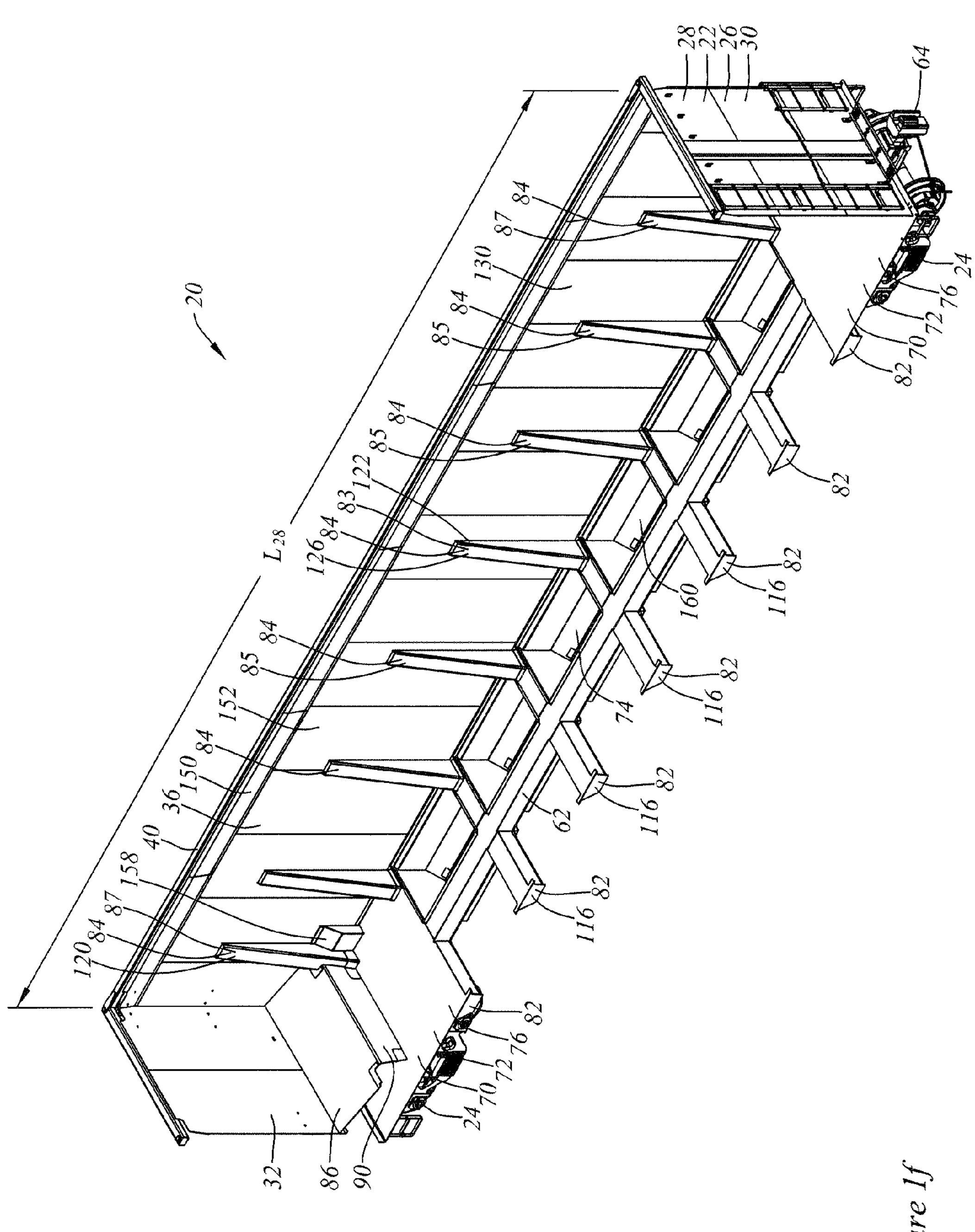
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Figure 1f

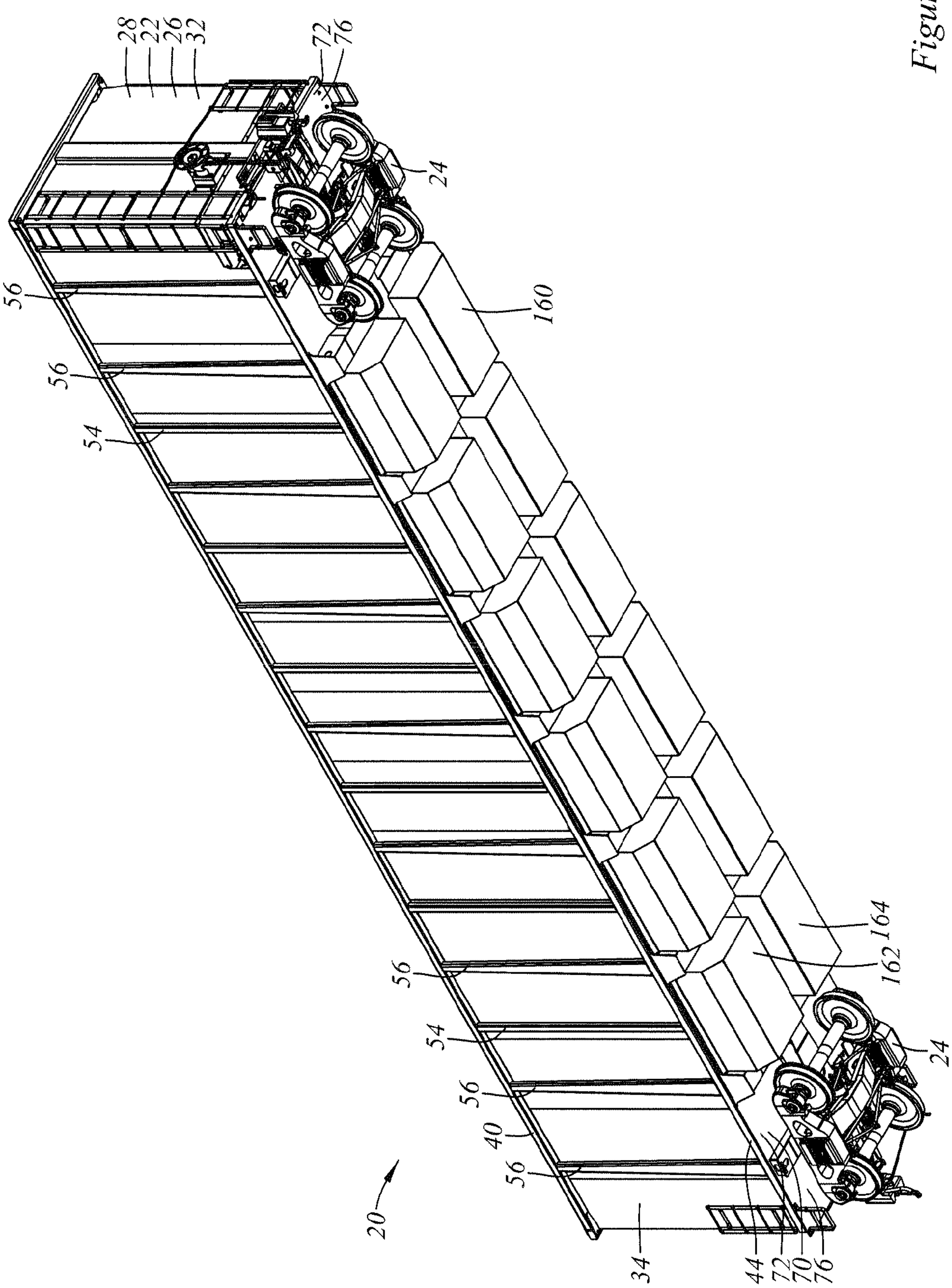
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Figure 1g

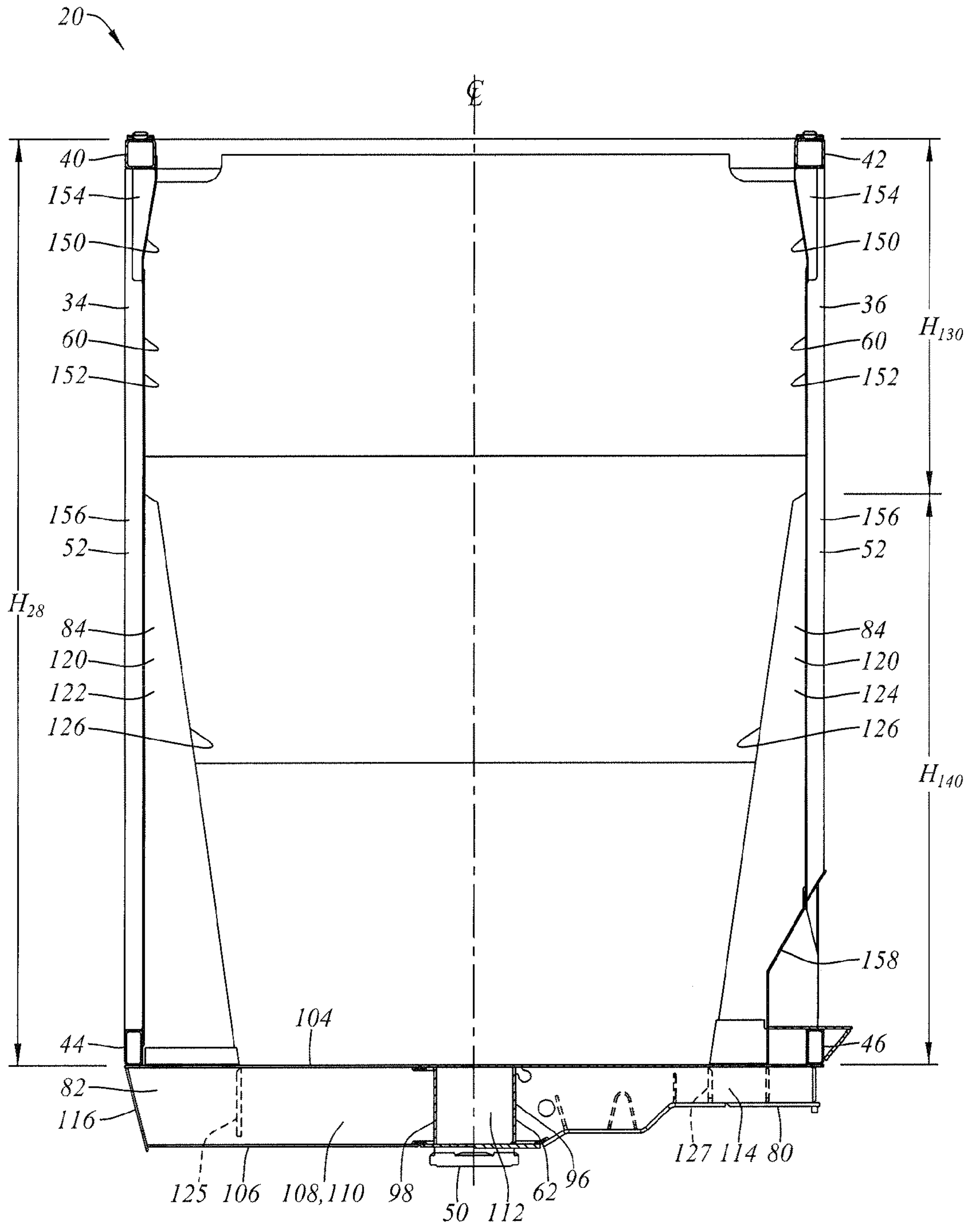
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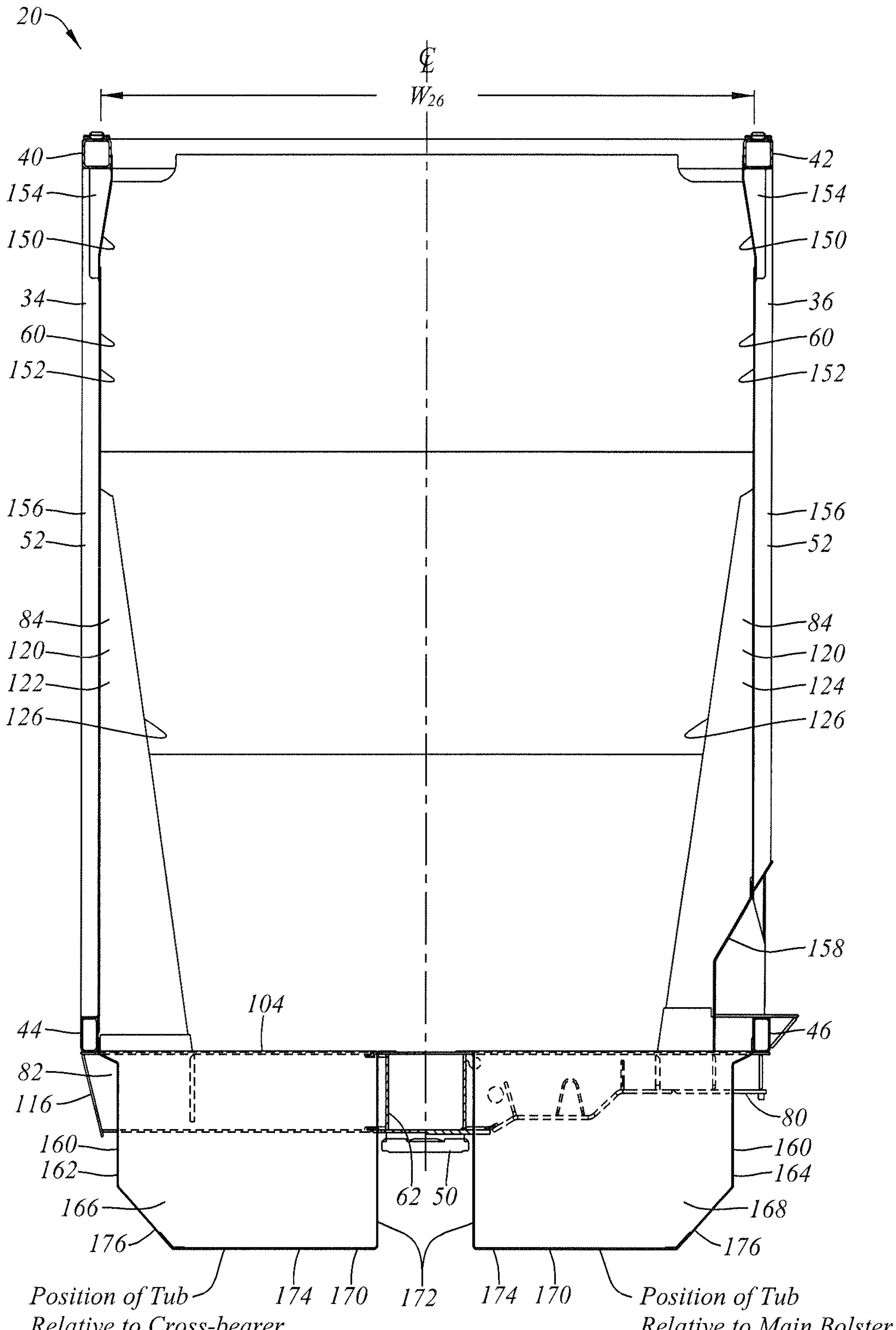
Figure 2a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174 170
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174 170
Position of Tub
Relative to Cross-bearer
Position of Tub
Relative to Main Bolster

Figure 2b

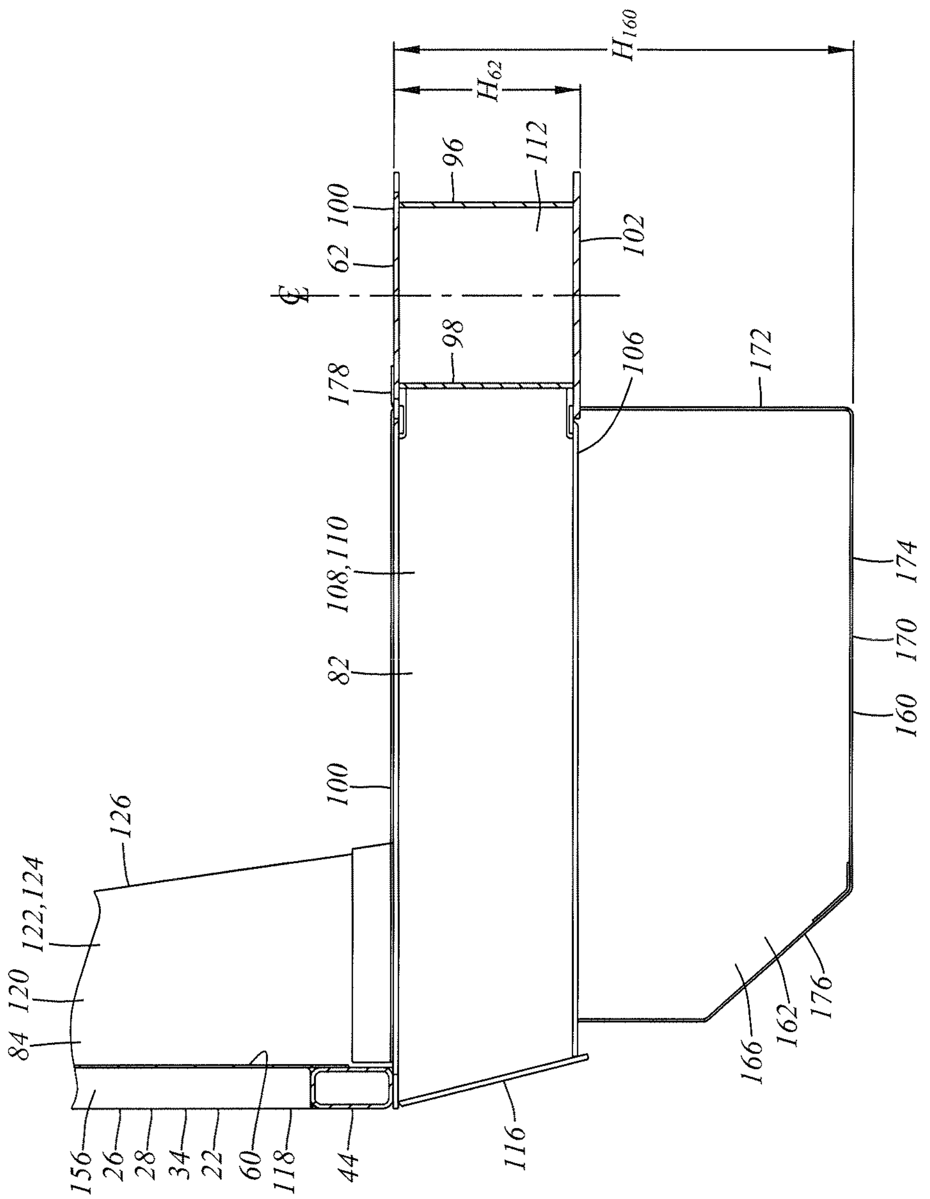
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Figure 2c

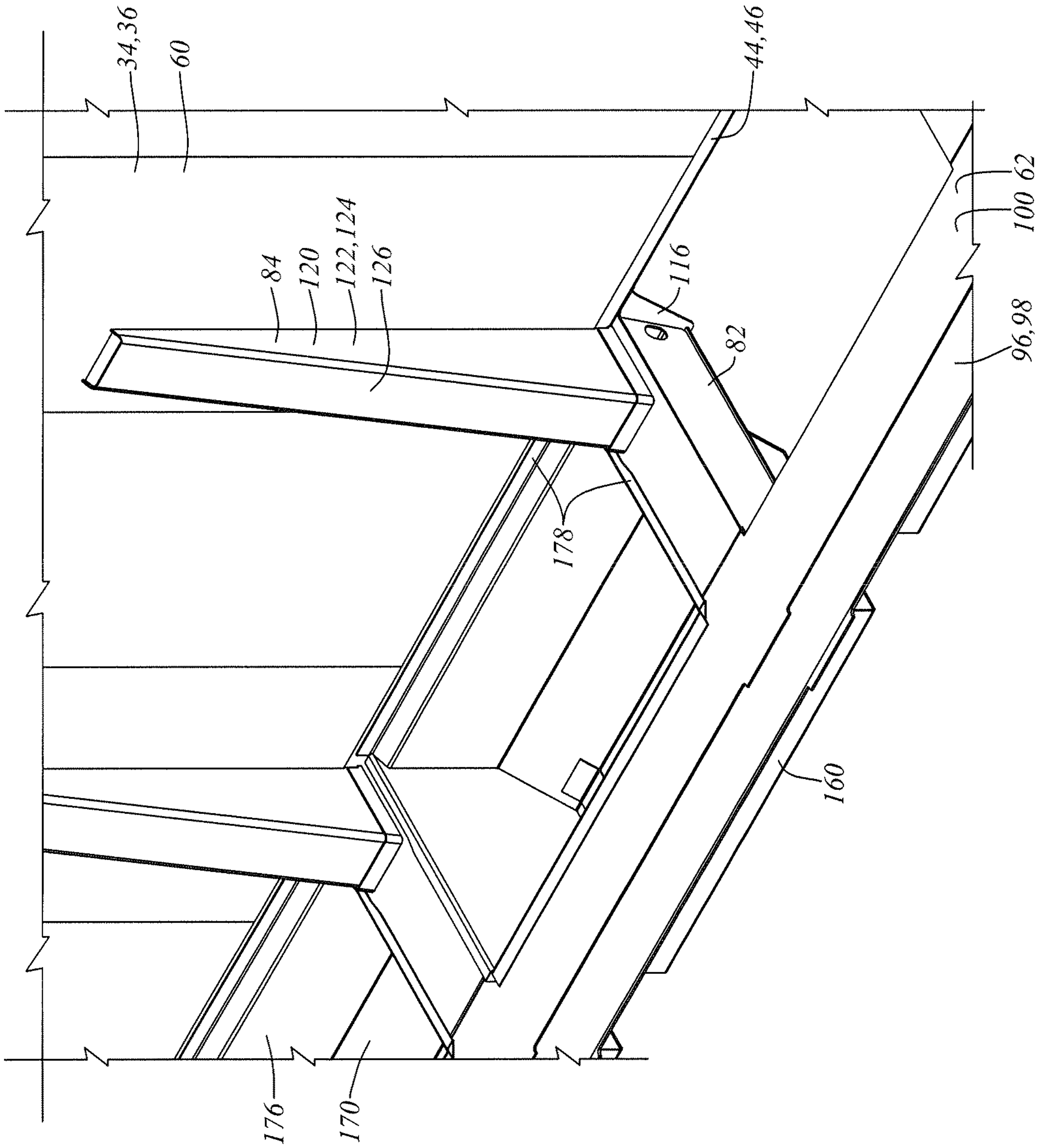
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Figure 2d

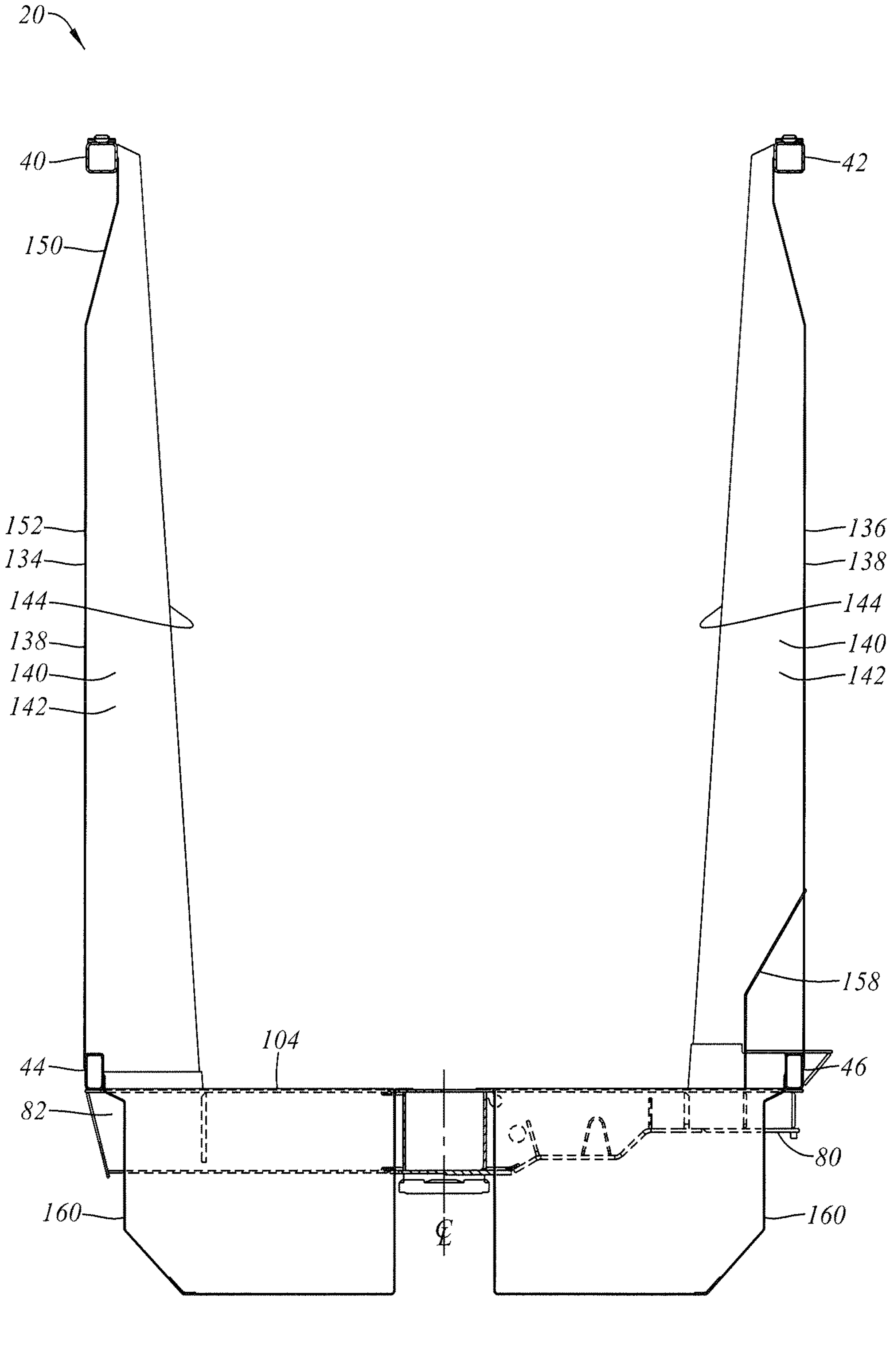
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Figure 2e

# RAILROAD GONDOLA CAR STRUCTURE

## FIELD OF THE INVENTION

This invention relates to the field of railroad freight cars, and, in particular to rail road gondola cars.

## BACKGROUND

It is often desirable for rail road cars to weigh out at the same time as they bulk out. For example, the maximum gross weight on rail of a "110 Ton" railroad freight car in North America is 286,000 lbs. If the car carries less than the maximum allowed lading by weight, then an unnecessarily high proportion of the weight being hauled is the weight of the car itself—which is also backhauled empty. Therefore, it follows that most often when relatively low density lading is to be carried it is desirable to have a high volume. This reflects conventional understanding in the railroad industry. Municipal waste tends to provide an example of relatively low density lading. Wood chips may provide another example.

It may be desirable to increase the size of the car by making the car taller. However, a fully laden car must not have a center of gravity more than 98 inches above top of rail (TOR). Therefore, is may also be desirable to extend the lading carrying envelope downward, below the upper flange (or top cover plate) of the center sill, below the height of the center of the couplers, and even below the bottom flange (or bottom cover plate) of the center sill. For this purpose a designer might consider the "bathtub" feature, of which the classic example is the bathtub gondola car shown and described in U.S. Pat. No. 4,361,097 of Jones et al., issued Nov. 30, 1982. As the walls of the gondola increase in height, there may not only be a center of gravity concern, but also a concern that the sidewalls of the car may begin to lack adequate side-ways stiffness. This may be particularly so where the car is to be emptied in a rotary dumping apparatus and where the length of the car has also been increased, with the truck centers being spaced more than, and possibly quite substantially more than, 46'-3" apart. Finally, it may be desired partially to compress the lading in the car. That is, in one example, it may be desired partially to compact municipal waste in the car as it is loaded.

## SUMMARY OF THE INVENTION

In an aspect there of the invention there is a gondola car. It has a center sill, cross-bearers extending laterally of the center sill, and a receptacle defining an accommodation for lading. The receptacle is mounted to the cross-bearers and including predominantly upstanding sidewalls. The sidewalls include side beams running parallel to the center sill, the side beams having a top chord, a side sill, and a side sheet extending between the top chord and the side sill. The side sill defines a torque tube mounted to resist lateral deflection of the top chord. Sidewall reinforcements extend predominantly upwardly from the side sills. The sidewall reinforcements being connected to respective ones of the cross-bearers at structural knees.

In a feature of that aspect of the invention, the gondola car is a bathtub gondola car. In a further feature the gondola car is an ice-cube tray gondola car. In still another feature at least a portion of the receptacle includes a lading accommodation region lying lower than the center sill. In another feature the receptacle has a width, the upstanding sidewalls have an height, and the height is greater than the width. In another feature, the receptacle has an inside length, and inside width, and an inside height measured upwardly of the center sill, wherein the length is at least five times as large as the width, and the height is at least as great as the width.

In another feature, the cross-bearers include a first cross-bearer having a pair of spaced apart webs, an upper flange and a lower flange. The reinforcements include a first reinforcement associated with the first cross bearer, the first reinforcement being connected to the first cross-bearer distant from the center sill. The first reinforcement has a pair of webs corresponding to the webs of the first cross-bearer. The reinforcement has a first flange spaced from the side sheet. The cross-bearer has an end cap mounted across the webs of the first cross-bearer. The end cap mates with the bottom flange and the top flange of the first cross-bearer. The first flange of the first reinforcement, and the side sheet, are mounted to transmit a moment couple to the upper and lower flanges of the first cross-bearer through the structural knee.

In another feature, the cross-bearers include a first cross-bearer having a pair of spaced apart webs, an upper flange and a lower flange. The reinforcements include a first reinforcement associated with the first cross bearer, the first reinforcement being connected to the first cross-bearer distant from the center sill. The first reinforcement has a pair of webs corresponding to the webs of the first cross-bearer. The first reinforcement has a first flange spaced laterally outboard from the side sheet. The first reinforcement has a second flange spaced laterally inboard from the first flange. The first cross-bearer has an end cap mounted across the webs of the first cross-bearer, the end cap having flange continuity with the first flange of the first reinforcement, the cap plate being mounted to transfer loads from the first flange of the first reinforcement into the webs of the first cross bearer. The first cross-bearer has a flange continuity member associated with the second flange of the first reinforcement, mounted between the top and bottom flanges thereof, the flange continuity member being mounted to transfer loads from the second flange of the first reinforcement to the webs of the first cross-bearer. The upper and lower flanges of the first cross-bearer are mounted to react loads transferred to the webs of the first cross-bearer from the first and second flanges of the first reinforcement.

In still yet another feature, the cross-bearers include a first cross-bearer having a pair of spaced apart webs, an upper flange and a lower flange. The reinforcements include a first reinforcement associated with the first cross bearer, the first reinforcement being connected to the first cross-bearer distant from the center sill. The first reinforcement has a pair of webs corresponding to the webs of the first cross-bearer. The first reinforcement has a first flange spaced laterally outboard from the side sheet. The first reinforcement has a second flange spaced laterally inboard from the first flange. The second flange has a length from a first end thereof mounted proximate to the first cross-bearer to a second end thereof distant from the cross-bearer; and over a majority of the length of the second flange, the side sheet is located laterally intermediate the first flange and the second flange of the first reinforcement.

In a further feature, the top chord has an enclosed cross-sectional area, a weight of section per unit of lineal measure, and a second moment of area in the lateral direction. The torque tube has an enclosed cross-sectional area, a weight of section per unit of lineal measure, and a second moment of area in the lateral direction. At least one of (a) the enclosed cross-sectional area of the top chord is greater than the enclosed cross-sectional area of the torque tube; (b) the weight of section of the top chord is greater than the weight of section of the torque tube; and (c) the second moment of area the top chord is greater than the second moment of area of the torque tube. In a further feature, all of (a), (b), and (c) are true.

In another aspect of the invention there is a rail road gondola car. The car has an underframe and a lading containment receptacle mounted thereto. The lading containment receptacle has a predominantly upstanding sidewall. The lading containment receptacle has an internal width, an internal length, and an internal height. The height is greater than the width. The receptacle is longitudinally asymmetric.

In another feature of that aspect of the invention, the receptacle has a feature of longitudinal asymmetry, the feature being a dog house formed at one end thereof. In another feature, the receptacle has a first end and a second end. At the first end the receptacle has a partial raised deck portion at one end thereof, the partial raised deck being unmatched at the second end. In another feature, the gondola car has a through center sill, the center sill has center plates mounted thereto for seating on corresponding center plate bowls of associated rail road car trucks. The center sill has a first end and a second end. The center sill has at least one of (a) brake reservoir, and (b) a brake valve, mounted at the first end thereof. The railroad car has an accommodation formed in the receptacle therefore. The accommodation protrudes longitudinally asymmetrically into the receptacle. In still another feature, the car has a volumetric capacity in excess of 8000 cu. ft.

In another aspect of the invention, there is a railroad gondola car having a receptacle for lading carried on trucks for rolling motion along railroad tracks. The receptacle includes upstanding sidewalls extending lengthwise along the car. The sidewalls include a top chord, a side sill, and predominantly upright side sheets extending therebetween. The sidewalls have predominantly upstanding side sheet reinforcements. The side sheet reinforcements include a first side sheet reinforcement having an outer flange and an inner flange, and a length. Over a majority of the length of the reinforcement the outer flange stands laterally outward of, and spaced from. the sheet. The inner flange stands laterally inwardly of the spaced sheet.

In a feature of that aspect of the invention, the rail road car includes rotary dumping fittings by which to grasp the receptacle for inversion. In another feature, the car has a through center sill, and receptacle has an inside width, and inside length, and an inside height measure upwardly of the center sill, the inside height being at least as great as the inside width; the car having a volumetric capacity greater than 8000 cu. ft. In a further feature, the first reinforcement includes an exterior member, the exterior member being a channel having first and second legs and a back defining the first flange, the legs having toes mounted to the side sheet; and the first reinforcement including an interior member, the interior member having webs and the second flange extending between the webs, the webs of the interior member having toes mounted to the side sheet substantially opposite the toes of the exterior member. In still another feature, the interior member tapers from a wide base adjacent the side sill to a narrower toe distant therefrom.

These and other aspects and features of the invention may be understood with reference to the description which follows, and with the aid of the illustrations of a number of examples.

## BRIEF DESCRIPTION OF THE FIGURES

The description is accompanied by a set of illustrative Figures in which:

FIG. **1***a* is a general arrangement, isometric view of a railroad freight car such as a gondola car that may incorporate the various aspects of the present invention, the view being taken from below and to one diagonal corner;

FIG. **1***b* is a general arrangement, isometric view of a the railroad freight car of FIG. **1***a* taken from above at that diagonal corner;

FIG. **1***c* is a side view of the railroad car of FIG. **1***a;*

FIG. **1***d* is a top view of the railroad car of FIG. **1***a;*

FIG. **1***e* is an end view of the railroad car of FIG. **1***a;*

FIG. **1***f* is a partial cut-away isometric view of the railroad freight car of FIG. **1***a* showing details of construction of the car;

FIG. **1***g* shows an alternate embodiment of gondola car to that of FIG. **1***a;*

FIG. **2***a* is a transverse sectional view of the railroad freight car of FIG. **1***a* taken on staggered section '**2***a*-**2***a*' of FIG. **1***e* looking longitudinally inboard;

FIG. **2***b* is a transverse sectional view of the railroad freight car of FIG. **1***e* taken on section '**2***b*-**2***b*' of FIG. **1***e* showing the relative relationship of the downwardly extending tubs to the bolster and cross bearers;

FIG. **2***c* is an enlarged detail of the railroad freight car of FIG. **2***a;*

FIG. **2***d* is an isometric view of the detail of FIG. **2***c;* and

FIG. **2***e* shows an alternate embodiment of gondola car to that of FIG. **2***b;*

## DETAILED DESCRIPTION

The description that follows, and the embodiments described therein, are provided by way of illustration of an example, or examples, of particular embodiments of the principles, aspects or features of the present invention. These examples are provided for the purposes of explanation, and not of limitation, of those principles and of the invention. In the description, like parts are marked throughout the specification and the drawings with the same respective reference numerals. The drawings are generally to scale unless noted otherwise. The terminology used in this specification is thought to be consistent with the customary and ordinary meanings of those terms as they would be understood by a person of ordinary skill in the railroad industry in North America. Following from decision of the CAFC in *Phillips v. AWH Corp.*, the Applicant expressly excludes all interpretations that are inconsistent with this specification, and, in particular, to confine the rule of broadest reasonable interpretation to interpretations that are consistent with actual usage in the railroad industry as understood by persons of ordinary skill in the art, or that are expressly supported by this specification, the inventor expressly excludes any interpretation of the claims or the language used in this specification such as may be made in the USPTO, or in any other Patent Office, other than those interpretations for which express support can be demonstrated in this specification or in objective evidence of record in accordance with In re Lee, (for example, earlier publications by persons not employed by the USPTO or any other Patent Office), demonstrating how the terms are used and understood by persons of ordinary skill in the art, or by way of expert evidence of a person or persons of at least 10 years experience in the railroad industry in North America or in other territories or former territories of the British Empire and Commonwealth.

In terms of general orientation and directional nomenclature, for railroad cars described herein the longitudinal direction is defined as being coincident with the rolling direction of the railroad car, or railroad car unit, when located on tangent (that is, straight) track. In the case of a railroad car having a center sill, the longitudinal direction is parallel to the center sill, and parallel to the top chords. Unless otherwise noted, vertical, or upward and downward, are terms that use top of rail, TOR, as a datum. In the context of the car as a whole, the term lateral, or laterally outboard, or transverse, or transversely outboard refer to a distance or orientation relative to the longitudinal centerline of the railroad car, or car unit, or of the centerline of a center plate at a truck center. The term "longitudinally inboard", or "longitudinally outboard" is a distance taken relative to a mid-span lateral section of the car, or car unit. Pitching motion is angular motion of a railcar unit about a horizontal axis perpendicular to the longitudinal direction. Yawing is angular motion about a vertical axis. Roll is angular motion about the longitudinal axis. Given that the railroad car described herein may tend to have both longitudinal and transverse axes of symmetry, except as otherwise noted a description of one half of the car may generally also be intended to describe the other half as well, allowing for differences between right hand and left hand parts. In this description, the abbreviation kpsi stands for thousand of pounds per square inch. To the extent that this specification or the accompanying illustrations may refer to standards of the Association of American Railroads (AAR), such as to AAR plate sizes, those references are to be understood as at the earliest date of priority to which this application is entitled.

As a further matter of definition, this specification may refer to structural cross-members. Cross-members most typically are either cross-bearers or cross-ties, particularly when used as underfloor supports. The cars may also include braces, often diagonal braces, in the nature of struts. A cross-bearer is a beam that carries loads applied cross-wise to the long axis of the member, and that has significant resistance to transverse bending. Although full width cross-bearers are used in cars that lack center sills, most commonly a cross-bearer has a moment connection at the center sill, and is mounted to accept vertical loads from the side beams of the car. The arms of a cross-bearer that extend away from the center sill may often be analyzed as cantilevers. A cross-bearer is usually considered to form part of the primary structure of the underframe of the railcar. A cross-tie is a beam, usually of smaller section than a cross-bearer, that typically does not have, or is not relied upon to have, a moment connection at the center sill such as to permit a moment couple to be transferred. A cross-tie is often relied upon to carry transverse loads, and has a second moment of area suitable for resisting bending. Most often the ends of a cross-tie (which "tie" the side sill to the center sill), are analyzed as being pinned connections that are not relied upon to transmit bending moments, but rather that carry vertical loads to simply supported ends. Cross-ties may often be used in intermediate floor spans between adjacent cross-bearers. A cross-tie may be considered secondary structure of the underframe, by comparison to cross-bearers and the main bolster. Cross-ties and cross-bearers both tend to run cross-wise i.e., cross-wise relative to the center sill, or longitudinal direction, of the car. A strut is a member that does not carry transverse loads, but rather is relied upon to carry uniaxial loads along its length in either tension or compression. A strut is not relied upon to have, and is usually not intended to have, a moment-couple connection, but is generally intended to have, and to be analyzed as having, a pin-jointed end the does not transmit a moment.

FIG. **1***a* shows an isometric view of an example of a railroad freight car **20** that is intended to be representative of a wide range of railroad cars in which the present invention may be incorporated. While car **20** may be suitable for a variety of general purpose uses, it may be taken as being symbolic of, and in some ways a generic example of a freight car having a straight through center sill. It may be a gondola car, in which lading is introduced by gravity flow from above. The gondola car may be a rotary dump gondola, and, in particular, may be a bathtub, or quasi-bathtub, gondola car as illustrated. Other than ancillary fittings, the structure of car **20** may tend to be symmetrical about its longitudinal centerline axis. Notably, as described below, the B end of the car is somewhat different from the A end of the car due to the asymmetric brake valve and reservoir installation. Otherwise, the car is also symmetrical about its transverse mid-span center line plane

By way of a general overview, car **20** may have a car body **22** that is carried on trucks **24** for rolling operation along railroad tracks. Car body **22** may typically be of all welded steel construction, or may be of mixed mild steel, aluminum, stainless steel or composite construction or any suitable combination thereof. Car **20** may be a single unit car, or it may be a multi-unit car having two or more car body units, where the multiple car body units may be connected at an articulated connector, or by draw bars. In gondola cars the density of lading may typically require that multi-unit cars be connected by draw bars rather than articulated connectors. Car body **22** may have a lading containment vessel, receptacle, accommodation or structure, or shell **26**. Shell **26** may include a generally upstanding wall structure **28** which may include a pair of opposed first and second end walls **30**, **32**, that extend cross-wise, and a pair of first and second deep side beam assemblies, that may be identified as sidewalls **34**, **36** that extend lengthwise. The end walls **30**, **32** and side walls **34**, **36** co-operate to define a generally rectangular form of peripheral wall structure **28**, when seen from above. In some embodiments the structure may be overlain by a cover **38**, such as may tend to permit the lading to be less exposed to wind, rain, snow, and so on, and, to the extent that the lading may be malodorous, perhaps also to contain the smell of the lading in some measure.

Wall structure **28** may include top chords **40**, **42** running along the top of sidewalls **34**, **36**, and side sills **44**, **46** running fore-and-aft along lower portions of side walls **34**, **36**. The side sills **44**, **46** may have the form or a closed hollow section, as indicated, this hollow section defining a torque tube that runs along the foot of the sidewalls of the car. Side walls **34**, **36** may act as deep beams, and may carry vertical loads to the main bolsters **80** that extend laterally from the center plates **50**, which seat in the center plate bowls of trucks **24**. Side sills **44**, **46** also act as a bottom flange of the beam in opposition to the top flanges of the beams defined by top chords **40**, **42**. In one embodiment, as shown, the torque tube may be a rectangular steel tube having upper and lower flanges, and inner and outer webs. Sidewalls **34**, **36** may also have vertical posts, or strakes, or stiffeners or reinforcements **52**, **54**, spaced therealong. Posts **52** may be wider, or may have a greater weight of section, than posts **54**. Those posts may be aligned with cross-bearers and cross-ties, respectively. These reinforcements, or posts, may have hollow sections and may be in the form of three sided channels of constant section as shown in FIG. **1***a,* or of tapering section as shown in the alternate embodiment of FIG. **1***g* as at **56**, with the toes welded inward against the web defined by the side sheet panels **60** of walls **34**, **36**, or the posts may be of three-sided section with the toes welded to the side sheet to form a hollow box as at **58**, with the base of the back or flange of the post adjoining the side sill being wider than the distal tip that adjoins the top chord. In each case, the depth of the resultant hollow section may be substantially the same as the width of the torque tube, i.e., the hollow structural section of the side sill, **44**, **46**.

Car **20** includes a straight-through center sill **62**, running from one end of the car body to the other. In the case of a single, stand alone car unit, draft gear and releasable couplers may be mounted at either end of the center sill. To the extent that the car is to be emptied in a rotary dumping apparatus, couplers **64** may be rotary couplers that allow the car to spin about a longitudinal axis running through the coupler centerlines.

The containment structure may include a bottom, floor or deck, indicated generally as **70**. This floor or deck serves to discourage downward escape of the lading. It may include end portions **72** and a central or intermediate portion **74**. End portions **72** may include a substantially planar shear plate **76** that runs between the bottom chords of the side sills, typically at the level of the top flange of the center sill and the top flanges of the arms **78** of the main bolster **80**. The shear plate **76** extends over truck **24**. The central or intermediate portion **74** lies between, and clear of, trucks **24** and may include first and second tub arrays **56**, **58** that extend downwardly of the level of the center sill top flange and of the side sills. Intermediate portion **74** extends over the major portion of the length of the car between the first cross-bearers immediately longitudinally inboard of the truck centers. Cross-bearers **82** may extend laterally from the center sill at spaced locations along the central portion of the center sill, and may connect the center sill and the side sills. Sidewall posts **52** may be mounted to sidesheets **60** in line with, and connected to the outboard ends of, cross-bearers **82**, and at the ends of the main bolster **80**. The smaller, intermediate posts **54** may be mounted in the half way spaces between the tapered posts. The car body may also include internal stiffening posts **84**, described in greater detail below.

At the ‘B’, or brake installation, end of the car, the deck may also include a raised end or “mezzanine” portion, or step deck **86** that lies longitudinally outboard of main bolster **80** and runs to the end wall of the car. The brake reservoir **88** and various brake fittings are mounted at the ‘B’ end of the car beneath this raised deck portion. There is a stub wall **90** that extends in a vertical plane above the outboard web **92** of main bolster **80**. A vertical main post **94** of a hollow section forming a rectangular tube rooted to the center sill runs up the end wall of the car. This mezzanine floor, or dog house feature to accommodate the brake valve and brake reservoir is an asymmetric feature, i.e., there is no corresponding feature at the ‘A’ end of the car. This results in a net volumetric gain at the ‘A’ end that may be of the order of 200 cu. ft., at a location well below the center of gravity and well below the 98 inches above TOR limit.

Straight-through center sill **62** may have vertical webs **96**, **98**, a top cover plate, or upper flange **100**, and a bottom cover plate or bottom flange **102**. The webs may be spaced to leave an inside width (e.g., 12⅞") to accommodate standard draft fittings and couplers. Top cover plate **108** may extend only over the length wise spanning distance of the tubs between end shear plates **76**, which then form the top flanges of center sill **62** over trucks **24**.

Cross bearers **82** also have the form of rectangular box beams, having a top flange **104** flush with top flange **100** of center sill **62**, the two meeting at a radiused root portion of the top flange at which a full penetration weld is made; a bottom flange **106** that is flush with bottom flange **102** of center sill **62** and is joined thereto in the same manner as upper flange **104**; and a pair of spaced apart side webs **108**, **110**. The center sill has internal webs **112** welded between webs **96**, **98** in line with webs **108**, **110** to provide web continuity across the center sill. The ends of cross-bearer arms **114** are capped by end plates **116** that have a broadened and radiused upper margin that is welded along the lower outer edge of the torque tube i.e., side sill **44**, in line with the outer, or back, flange of the posts **52**, thus providing a single continuous broad load path through which stresses in the post flange **118** may be carried into the end of the bolster. The main bolster is similarly constructed as a box, with the usual geometry for accommodating the side bearings and clearing the wheels.

Wall reinforcements **120** in the nature of internal stiffening posts **84** are mounted to alternate pairs of cross-bearers **82**, and serve to discourage the side walls from bulging outwardly under load. As indicated, posts **84** are mounted at the longitudinal stations of the central cross-bearers, as at **83**, the second pair of longitudinally outboard cross-bearers as at **85**, and at the main bolsters, as at **87**. Stiffening posts **84** include generally triangular side sheets **122**, **124**, and an inclined flange **126**. The triangular side sheets **122**, **124** are welded to the top cover **104** of the respective cross-bearers **82** with slightly narrower separation than webs **108**, **110** of cross-bearers **82** themselves, leaving an exposed shoulder **128**, as indicated in FIG. **2***d*. A gusset **125** is mounted inside the respective cross-bearer **60** (or gusset **127** inside the arm of the main bolster) to provide flange continuity above and below the top cover. It may be noted that at these locations the depth of the reinforcement is the combined depth of the internal reinforcement and the external tapered post that is aligned with the reinforcement at that cross-bearer. In these locations, the side sheet of the side wall actually lies in an intermediate location between the outer fiber (the back of the external post) and the innermost fiber (the flange of the internal stiffener). In effect, this junction forms a large structural knee. For the purpose of this specification, a structural knee is formed where a pair of flanges (which may include web or flange continuity gussets) of a first beam and a pair of flanges from a second beam form a quadrilateral connected to four edges of a mutually shared shear plate (or shear plates). Typically, the flange pairs intersect, and the shear plate lies in a plane that is mutually perpendicular to both pairs of flanges. In the instant example, the flanges of the cross-bearer carry a moment couple that opposes the moment couple carried by flange **96** and the flange of post **39** as carried through the sidewall of the side sill and end plate **90**. The webs of the cross-bearer form the resolving planes, or members, where these moment couples meet and are balanced. The resultant structure is, in essence, a very large U-shaped spring made up of one of the cross-bearers as the back and two of the tapered side-posts in combination with two of the tapered internal supports as the legs. The legs of the spring then extend upward to the top chord, and may tend to resist lateral deflection of the top chords, whether inward under longitudinal squeeze loads when empty, or outwards under the pressure of the lading.

At these locations the through-thickness depth of the reinforcement is the combined depth of the internal reinforcement and the external tapered post that is aligned with the reinforcement at that cross-bearer. In these locations, the side sheet of the side wall actually lies in an intermediate location between the outer fiber (the back of the external post) and the innermost fiber (the flange of the internal stiffener). The inset of the side sheet is the same as the depth of the legs of the outside reinforcement. That depth may be in the range of 2"-6", and, in one embodiment may be about 3". The side sheet extends in a plane parallel to the plane of the back flange of the sidewall stiffener.

In one embodiment, as shown in FIGS. **1***f* and **2***d*, internal reinforcements **120** do not extend to the full height of the car. Rather they terminate at a height well short of the top chord, and there is a region of the side wall, indicated as upper region **130**, that is free of internal obstructions or protrusions such as posts **84**, and, above this height the walls a reinforced only externally, as by the upper or distal end regions of posts **52** and **54**. The vertical extent of this region is indicated as $H_{130}$. This may permit a compaction device, or press, or hammer, to work on the lading as it is loaded from above, while tending to avoid damage to the internal posts (because of the clearance height) and to the external posts (because they are outside the side wall sheet). In one embodiment, $H_{130}$ may be of the order of 4-8 feet, and may be about 6 ft. Expressed differently, $H_{130}$ may be in the range of ⅕ to ⅗ of the overall height of side wall **34** (or **36**) from side sill **44** (or **46**) to top chord **40** (or **42**), and in one embodiment may be in the range of about ¼ to ½ of that height, and in another embodiment may be in the range of about ⅓ to ⅜ of that height.

In another embodiment, as shown in FIG. **2***e,* where, perhaps, the internal stiffeners may not be as exposed to possible damage from loading and unloading equipment in quite the same way, the car has sidewalls **134**, **136** having sidewall sheets **138** and internal stiffeners **140**. In this instance, sidewall stiffeners **140** have a base or root, or proximal end at deck **70**, and a tip or distal end at, or adjoining, or connected to top chord **40** or **42**. Stiffeners **140** may be understood to have the same structural knee connection to the cross-bearers or main bolster as described above. Stiffeners **140** may be substantially triangular when viewed in profile, having a pair of spaced apart triangular side webs **142** having a wide base at deck **70** and the narrow tip at top chord **40** (or **42**), and an inner back or flange **144**. Webs **142** may be planar and parallel, or may taper from a wide spacing at deck **70** to a narrower spacing at top chord **40** (or **42**). Flange **144** may correspondingly be of constant width or of tapering width. The vertical outboard edges of webs **142** may abut side sheet **138**, which, in this instance, is located at the external extremity of the car body. i.e., this embodiment is free of, or substantially free of, vertical reinforcing posts located outboard of the sidesheets. As such it may gain volumetric capacity by the increase in width between the sidesheets of the opposites sidewalls of the car.

In either case, the upper region of the sidewalls includes a dog-leg, or kink, or sweep, or angled skirt portion, indicated as **150** that joins the main, substantially planar portion **152** of side sheet **60** (or **138**, as may be) along its upper vertex, and then runs upwardly and inwardly on a slope to mate with the inboard edge of top chord **40** (or **42**). In the case of the embodiment of FIG. **1***a,* closure members, or webs, or gussets **154**, of generally triangular shape, are mounted between the sides **156** of the reinforcement posts **52**, **54** and portion **150**. Portion **150** may itself have a bent lower edge such that a lap joint may be formed with the upper margin of the main portion of sidewall sheet **60** (or **138**).

In the embodiment of FIG. **1***a,* top chord **40** (or **42**) has a section that has greater depth in the lateral direction than the depth of the external sidewall support posts **52**, **54**. In some embodiments, this lateral depth of section may be greater than the through thickness of the torque tube i.e., side sill **44**. For example, the top chord may have a section of 5×5 inches, whereas the torque tube may be 3×6 inches. The top chord has a greater enclosed cross-sectional area, a greater second moment of area in the lateral direction, and a greater weight of section per unit of lineal measure than the torque tube. Also in the embodiment of FIG. **1***a,* the depth of the side reinforcement may be such as to be equal to, or substantially equal to, the depth accommodation required for safety appliances, such as the ladders mounted at the points (i.e., the corners) of the car, such that those safety appliances may lie predominantly or entirely within the outer width envelope of the car overall as defined by the outer extremity of the backs of the posts. That is, the ladders lie predominantly or completely within the envelope of the side reinforcement posts.

At each end, at the location of the main bolster, there is an accommodation **158**, which may be a rotary dumping apparatus engagement member accommodation. This accommodation may permit a claw of a rotary dumping machine to grasp the car body prior to rotation. To the extent that car **20** is a rotary dump gondola, the members of the car defining the lading containment envelope, i.e., the predominantly upstanding sidewall members of the side beams and end walls, and the tubs defining the lading carrying portions of the car that lie downwardly of the level of the top flange of the center sill, may be free of discharge gates such as might be found in a flow through car. The rotary dumping equipment may include clamping elements or claws that tend to draw the car downwards, i.e., to compress the springs of the trucks, to keep the car firmly clamped on the rails. The equipment may also include clamping members that bear against the outsides of the posts. The inward step of the side sheets relative to the exterior post flanges may tend to mean that clamps of the rotary dumping equipment may bear against the relatively laterally stiff post flanges, rather than against the relatively laterally less robust side sheets.

Tubs **160** of tub left and right tub arrays **162**, **164** may be prefabricated liners, or buckets, or baskets, or troughs, or simply tubs (however they may be termed) that have a uniform size corresponding to the generally rectangular envelope defined between adjacent pairs of cross-bearers **82**, center sill **62**, and side sill **44** or **46**. Each tub **160** has a pair of end walls **166**, **168**, and a base wall **170** that may be bent to yield an inside wall **172**, a bottom wall, **174**, and a dog-legged outer wall **176**. The general form of base wall **170**, as bent, conforms to the profile of end walls **166**, **168**. Each of walls **166**, **168** and **170** has a bent lip, such as indicated at **178**, that, on installation, overlaps the adjacent cross-bearer top cover plate or center sill top cover plate, as may be, and is welded thereto accordingly. The upper margin of outer wall **176** overlaps and is welded to the inside web of side sill **44** or **46** as may be. The tub materials are generally thinner than the flange materials of the cross-bearers and center sill. In the event that the tubs are damaged or wear out, to the extent that they do not form any portion of the primary structure of the railroad car underframe (i.e., the center sill, cross-bearers and main bolster, the side sills), they can be replaced as modular single units without having to cut, remove or otherwise damage the underlying primary structure.

It may be noted that the underside of the car resembles an ice-cube tray to some extent. As such, the term "ice-cube tray gondola car" used herein means a bathtub gondola car in which the "bathtub" is subdivided into smaller tubs by the center sill and the cross-bearers, such that the resulting gondola car has an array of tubs that resembles an ice-cube tray. In one embodiment of such a car, as illustrated, there are several cross-members, be they cross-bearers or cross-ties or such like that perform a structurally equivalent function, spaced longitudinally along the middle portion of the car between the trucks, and a series of lading containing members, such as might be termed buckets, or tubs, mounted to sit between the cross-members. The bottom portion of the car may thereby tend to have the appearance, at least in part, of an ice-cube tray. In some embodiments the cross-members may tend to lie flush, or roughly flush, with the top cover plate of the center sill. In some embodiments the tubs may tend to extend downwardly beyond the cross-members. Aside from the modularity of the tubs, the use of both (a) cross-bearers capable of carrying a bending moment, and (b) a series of tubs, may tend to yield a car with increased lading capacity (as compared to a traditional gondola with a floor flush with the top cover of the center sill); a reduced center of gravity height as compared to a car with a floor flush with the top cover of the center sill (due to lading being carried lower on the car than otherwise); and intermediate bending-moment-carrying structural members such as may resist lateral deflection of the sidewalls. In some embodiments this may be done without providing strut work inside the body of the car such as might otherwise perhaps be more vulnerable to, or more prominently exposed to, abusive loading (or unloading) practices, or upon which refuse or other objects loaded into the car might otherwise be prone to catch or snag during removal. That is, a railcar used for carrying municipal waste may not necessarily always be loaded with the utmost care and precision. Such cars may be subject to abuse, and it may be helpful for the structure of the car to be both (a) relatively robust; and (b) less exposed. The cross-members described lie under the floor sheets of the car, such that, in expected use, lading should not be able to be caught under or behind the cross-members as it may do with more exposed struts and ties as sometimes seen in coal or other gondola cars. When the car is emptied in a rotary dumper, the lading should fall out without becoming hung up on internal struts. In some embodiments, such as that shown, the car may be entirely free of such struts. Alternatively, to the extent that such struts may still be desired or required, nonetheless, the presence of the moment-coupled spring-like structures may tend to reduce the number of such strut members employed.

The structure described above may be used in the context of a gondola car having an high aspect ratio. That is, the car has, at least in the context of gondola cars, an abnormally large ratio of wall height to car width. The wall height, $H_{28}$, measured from the bottom of the side sills to the top of the top chord, is greater than the car width between the side sheets, indicated as $W_{26}$. In one embodiment, the ratio of height to width is greater than 5:4. In another is in the range of about 11:8 to about 3:2 (+/−). In one embodiment the height is 155" and the width is 108". The height of the braces, namely of wall reinforcements **62**, indicated as $H_{62}$, is greater than ⅓ of the car width $W_{26}$. It may be greater than ⅗ of the car width, and, in one embodiment, as illustrated, it may be greater than half the car width, and may be in a ratio of roughly 5:3 to 2:1 relative to the car half width. In one embodiment it may be about 85" to 100". Expressed differently, the reinforcements may have a base width $W_{26}$, that is more than ⅛ of the wall height, $H_{28}$. In one embodiment the ratio of $W_{26}$:$H_{28}$ may lie in the range of ⅙ to ⅓, and in one embodiment may be about ⅕. Expressed differently yet again, the ratio of the height $H_{140}$ to height $H_{28}$ may be greater than 1:4, and may lie in the range of 3:10 to 7:10, and, in one embodiment, may be about ⅝ to ⅔ (+/−). In one embodiment, the truck centers are between 58 and 60 ft apart, $H_{28}$ is roughly 13 ft. In another embodiment, the inside length of the car is greater than 80'-0" and may be over 85'-0" with a length over the strikers of more than 89'-0" such that internal volume is greater than 10,000 $ft^3$. The overall height of the car, including a 6" (+/−) deep cover, from top of rail may conform to AAR Plate F (i.e., 204"). The inside width $W_{26}$ is 9 ft, and the inside length is just over 67 ft. The height of the center sill top cover is about 43" above TOR, and the clearance of the tubs is 9'-10" from TOR. The depth of the center sill $H_{62}$ is about 14" and the overall depth of the tubs is about 34". The tubs extend downwardly about 20 inches beyond the bottom of the cross-bearers, (and, to the extent the cross-bearer and center sill bottom flanges are flush, also beyond the center sill bottom flange). The tubs **160** not only extend downwardly beyond the center sill and cross-bearers, but are therefore roughly 2-2½ times as deep as the cross-member and center sill. The cross-bearers are about 12" wide, and are spaced on roughly 92"-93" centers, with 80" long×50" wide tubs **160** seated between the adjacent cross-bearers. The internal volume of the car may be greater than 7500 cu. ft., and, in one embodiment, may be roughly 8700 cu. ft. By most standards, this would be considered a high volumetric capacity gondola car. The volume of the ice-cube trays (i.e., the volume of the arrays of tubs **162**, **164** shy of the level of the center sill top cover plate **100**, may be over 500 cu. ft., may be over 750 cu. ft, and may be roughly 900 cu. ft. for the array of 12 trays shown. Expressed differently, the depressed portion of the lading carrying volume may be more than 5% of the volume of the car, may be more than 1⁄12 of the total volume of the car, and, in one embodiment, may account for more than 10% of the volume of the car. The ratio of the depth $H_{160}$ of the tubs **160** below the center sill top cover plate **100** to the height of the sidewalls $H_{28}$ measured upwardly from the top cover plate may be more than 1:10, and may lie in the range of 1:13 to roughly 1:4, and, in one embodiment is about 1:5 (in one embodiment it is, roughly 33":156"). The car may also relatively long as compared to the width of the car, and tall compared to its length. That is, in one embodiment the length of the car, inside the endwalls $L_{28}$, may be more than five times the inside width of the car, and the wall may be taller than the inside width. In another embodiment, the car is between 6 and 8 times as long as it is wide. It may also have a sidewall height that is greater than ⅛ of the inside length, and may be in the range of ⅙ to ¼ of that length.



Car **20** may thus have the combination of (a) side sill torque tubes; (b) sidewall stiffeners that are mounted to the cross-bearers at structural knees; and (c) a lading containment envelope that extends below the level of the top flange of the center sill. The lading containment envelope may be defined, at least in part, by a lower portion of the car between the trucks that defines a bathtub. That lower portion may be either a single tub, or a double tub, and may be an "ice-cube tray" array of tubs. Car **20** may have predominantly upwardly extending sidewall stiffeners having an outboard flange member, a co-operating inboard flange member spaced from the outboard flange member. Over at least a non-trivial proportion of the length of the stiffeners, the sidewall sheet is carried in an intermediate position between the inboard and outboard flange members.

Various embodiments have been described in detail. Since changes in and or additions to the above-described examples may be made without departing from the nature, spirit or scope of the invention, the invention is not to be limited to those details.

I claim:

**1**. A gondola car comprising:
a center sill;
cross-bearers extending laterally of said center sill;
a receptacle defining an accommodation for lading, said receptacle being mounted to said cross-bearers and including predominantly upstanding sidewalls;
said sidewalls including side beams running parallel to said center sill, said side beams having a top chord, a side sill, and a side sheet extending between said top chord and said side sill;
said side sill defining a torque tube mounted to resist lateral deflection of said top chord;
sidewall reinforcements extending predominantly upwardly from said side sills; and
said sidewall reinforcements being connected to respective ones of said cross-bearers at structural knees.

**2**. The gondola car of claim **1** wherein said gondola car is a bathtub gondola car.

**3**. The gondola car of claim **1** wherein said gondola car is an ice-cube tray gondola car.

4. The gondola car of claim **1** wherein at least a portion of said receptacle includes a lading accommodation region lying lower than said center sill.

5. The gondola car of claim **1** wherein:

said cross-bearers include a first cross-bearer having a pair of spaced apart webs, an upper flange and a lower flange;

said reinforcements include a first reinforcement associated with said first cross-bearer, said first reinforcement being connected to said first cross-bearer distant from said center sill;

said first reinforcement having a pair of webs corresponding to said webs of said first cross-bearer;

said first reinforcement has a first flange spaced from said side sheet;

said first cross-bearer has an end cap mounted across said webs of said first cross-bearer, said end cap mating with said lower flange and said upper flange of said first cross-bearer;

said structural knees including a first structural knee associated with said first cross-bearer and said first reinforcement;

said first flange of said first reinforcement and said side sheet being mounted to transmit a moment couple to said upper and lower flanges of said first cross-bearer through said first structural knee.

6. The gondola car of claim **1** wherein:

said cross-bearers include a first cross-bearer having a pair of spaced apart webs, an upper flange and a lower flange;

said reinforcements include a first reinforcement associated with said first cross-bearer, said first reinforcement being connected to said first cross-bearer distant from said center sill;

said first reinforcement has a pair of webs corresponding to said webs of said first cross-bearer;

said first reinforcement has a first flange spaced laterally outboard from said side sheet;

said first reinforcement has a second flange spaced laterally inboard from said first flange;

said first cross-bearer has an end cap mounted across said webs of said first cross-bearer, said end cap having flange continuity with said first flange of said first reinforcement, said end cap being mounted to transfer loads from said first flange of said first reinforcement into said webs of said first cross-bearer;

said first cross-bearer having a flange continuity member associated with said second flange of said first reinforcement, said flange continuity member being mounted between said upper and lower flanges of said first cross-bearer, said flange continuity member being mounted to transfer loads from said second flange of said first reinforcement to said webs of said first cross-bearer; said upper and lower flanges of said first cross-bearer being mounted to react loads transferred to said webs of said first cross-bearer from said first and second flanges of said first reinforcement.

7. The gondola car of claim **1** wherein:

said cross-bearers include a first cross-bearer having a pair of spaced apart webs, an upper flange and a lower flange;

said reinforcements include a first reinforcement associated with said first cross-bearer, said first reinforcement being connected to said first cross-bearer distant from said center sill;

said first reinforcement has a pair of webs corresponding to said webs of said first cross-bearer;



said first reinforcement has a first flange spaced laterally outboard from said side sheet;

said first reinforcement has a second flange spaced laterally inboard from said first flange;

said second flange has a length from a first end thereof mounted proximate to said first cross-bearer to a second end thereof distant from said first cross-bearer; and

over a majority of said length of said second flange, said side sheet is located laterally intermediate said first flange and said second flange of said first reinforcement.

8. The gondola car of claim **1** wherein:

said top chord has an enclosed cross-sectional area, a weight of section per unit of lineal measure, and a second moment of area in the lateral direction;

said torque tube has an enclosed cross-sectional area, a weight of section per unit of lineal measure, and a second moment of area in the lateral direction; and

at least one of (a) said enclosed cross-sectional area of said top chord is greater than said enclosed cross-sectional area of said torque tube;

(b) said weight of section of said top chord is greater than said weight of section of said torque tube; and

(c) said second moment of area said top chord is greater than said second moment of area of said torque tube.

9. The gondola car of claim **1** wherein said receptacle has a width, said sidewalls have an height, and said height is greater than said width.

10. The gondola car of claim **1** wherein said receptacle has an inside length, an inside width, and an inside height measured upwardly of said center sill, wherein said inside length is at least five times as large as said inside width, and said inside height is at least as great as said inside width.

11. A rail road gondola car, said rail road gondola car having an underframe and a lading containment receptacle mounted thereto, said lading containment receptacle having a predominantly upstanding sidewall; said lading containment receptacle having an internal width, an internal length, and an internal height, said internal height being greater than said internal width; and said receptacle being longitudinally asymmetric.

12. The rail road gondola car of claim **11** wherein said receptacle has a feature of longitudinal asymmetry, said feature including a raised end deck portion defining a sheltered machinery accommodation space thereunder.

13. The rail road gondola car of claim **11** wherein said receptacle has a first end and a second end; at said first end said receptacle has a partial raised deck portion at one end thereof, said partial raised deck portion being unmatched at said second end.

14. The rail road gondola car of claim **11** wherein:

said rail road gondola car has a through center sill, said center sill having center plates mounted thereto for seating on corresponding center plate bowls of associated rail road car trucks, said center sill having a first end and a second end;

said railroad gondola car has an accommodation formed in said receptacle, said accommodation protruding longitudinally asymmetrically into said receptacle;

said accommodation being of a size to shelter therewithin at least one of (a) a brake reservoir, and (b) a brake valve.

15. The rail road gondola car of claim **14** wherein said car has a volumetric capacity in excess of 8000 cu. ft.

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